VOLUME XLIII • NUMBERS 3–4
May 1961

THE Biologist

A
terly Journal
Promoting
arch Interest
in the
gical Sciences

Contents

The Biology and Economic Importance of the Dermestidae
By Melville H. Hatch 33

The Survey Course
By a Graduate Student in Zoology 47

Enter, A Spiritual Leader!
By E. A. Seaman 50

Book Notices 55

THE Biologist

The Biologist is the official publication of the Phi Sigma Society, a nonprofit educational organization devoted to the promotion of research interest in the biological sciences, founded at Ohio State University 17 March 1915. Phi Sigma is a member of the Association of College Honor Societies and the American Institute of Biological Sciences and an Associate Member of the American Association for the Advancement of Science.

The Biologist is issued as a stimulus to the fellowship in science for which Phi Sigma stands and as a medium of exchange between Chapters. The Editor solicits for possible publication zoological or botanical or general biological papers, exclusive of reports on research. The Council Officers assume no responsibility as to the opinions of the contributors to this publication.

THE COUNCIL

Honorary President: PROF. THOMAS PARK, Department of Zoology, University of Chicago, Chicago 17, Illinois

President: DR. HENRY VAN DER SCHALIE, Museum of Zoology, Ann Arbor, Michigan

Past President: DR. KARL F. LAGLER, Department of Fisheries, University of Michigan, Ann Arbor, Michigan

Vice-President: DR. HORTON H. HOBBS, JR., Department of Biology, University of Virginia, Charlottesville, Virginia

Executive Secretary-Treasurer: DR. FRED S. ORCUTT, Department of Biology, Virginia Polytechnic Institute, Blacksburg, Virginia

Editor: DR. MELVILLE H. HATCH, Department of Zoology, University of Washington, Seattle 5, Washington

The Biology and Economic Importance of the Dermestidae

MELVILLE H. HATCH

Department of Zoology, University of Washington

THE DERMESTIDAE constitute a family of beetles that includes about 700 species of which about 50 species have been recorded on stored organic products of one sort or another and may be considered of actual or potential economic importance. The family includes four genera which include stored product pests of primary importance:

Dermestes, the larder and hide beetles.
Attagenus, including the black carpet beetle.
Anthrenus, including varied and furniture carpet beetles.
Trogoderma, including the cabinet beetle and the khapra beetle.

These beetles are so important that every book and pamphlet on household or stored product insects always contains a section on them. The most detailed account of the stored product Dermestidae is the 168 pages (pp. 234–401) devoted to this family in H. E. Hinton's 1945 "Monograph of the Beetles Associated with Stored Products," but this book confines itself to the structure and habits of the species without discussing control measures. The current American specialist on the Dermestidae is Richard S. Beal, who published a monograph of the genus Trogoderma in 1954, and is at present working on several of the other genera. The most detailed discussion of control measures against carpet beetles with which I am acquainted is the National Pest Control Association Technical Release 5-54, dated May 14, 1954, a 27 page discussion of the "Biology and Control of Clothes Moths and Carpet Beetles." While the general identification of our more important Dermestidae is, as I shall point out, a simple matter, their precise identification to species is a relatively technical affair.

We have had a recent example in California in connection with the khapra beetle, *Trogoderma granarium* Everts, of the dangers surrounding inadequate identification. This dangerous granary species until recently was known exclusively from the Old World. As early as 1946 it apparently began to be taken in California, but for seven years was mistaken for the much less dangerous black carpet beetle, *Attagenus piceus* Ol. By October, 1953, when it was finally recognized, it occurred in 154 premises in 24 counties in California, Lower California, Arizona, and New Mexico. Ordinary identifications are probably adequate in the case of household infestations, but where commercial operations of any moment are involved, more care should be taken. Moreover, in submitting specimens for identification, send in adults as well as larvae wherever possible, and as many as 8 or 10 or more adults where they can be found. In certain of the genera, precise identifications are based on structural features present only in the male, and by submitting a number of specimens, the chances of including a male are greatly increased.

The Dermestidae, as I said before, are a family of some 700 species, about 50 of which have been recorded from stored products. They are one of the numerous centrally situated families of Coleoptera known as Clavicornia from the fact that they have the terminal segments of the antennae enlarged to form a sensory club, such enlarged segments being especially abundantly provided with sensory bristles. Among the bodily features that coleopterists employ to distinguish Dermestidae from related families are the prominent cylindrical basal segments of the front legs, the procoxae, and the grooves on the under surface of the beetle which receive the legs when the insect is in repose. Somewhat easier for the layman to observe is the presence on the under surface of most of the hide and larder beetles of extensive areas of brilliant white pile. The carpet beetles possess a simple eye or ocellus on the middle of the upper surface of the head between the two large compound eyes and are the only beetles known to possess such a structure. The ancestral insect, from which the beetles are supposed to have evolved some 200 million years ago, probably possessed three such simple eyes on the front of the head, the middle one of which is preserved in the carpet beetles. In passing it may be noted that a few other beetles in the family Staphylinidae preserve a pair of simple eyes, but no beetle has all three simple eyes of the insect ancestor.

With one peculiar and partial exception, adult Dermestids are all provided with fully functional wings which enable the beetles to fly freely from place to place, but which are folded up compactly under the wing covers when the insect is not in actual flight. This is important in the life of the beetles because it enables them to get from place to place freely and to search out and populate new situations that are suitable for rearing new brood. The partial exception is *Thylodrias contractus* Mots., most appropriately called the "odd beetle." In this species only the males ever develop flying wings. The female remains larviform without either wings or wing covers. So far the insect has been found in houses in Transcaucasus and Russia in the Old World, and in New York, Wisconsin, Ontario and

Texas in North America, as attacking insect specimens and silk clothing. Up to the present its native habitat is unknown, although it is assumed not to be indigenous in North America.

So much for the adult Dermestid. Most of the damage that these beetles do is done in the larval stage, so that it is important to be able to recognize that stage likewise. First, make sure that it is a beetle larva by counting the legs. If it has more than three pairs of legs it is the caterpillar of a moth and not a beetle grub at all. To be a Dermestid larva, it must be well provided with conspicuous brown or blackish hairs and to straighten out in a horizontal position when walking—not curling up after the fashion of a white grub. These are completely non-technical characters, but, taken in conjunction with the mode of occurrence in the household or infesting stored products will usually indicate that a Dermestid larva is involved.

The basic biological adaptation of the Dermestidae is a dependence on dry animal matter as a source of food. The primitive condition in the family is represented by the hide and larder beetles, in which both larvae and adults live in the same habitat and feed on the same type of food. Among the carpet beetles, however, the food habits tend to deviate from the primitive condition. The larvae continue, with some important exceptions, to subsist on material of animal origin, but the adults of Attagenus and Anthrenus tend to transfer to a diet of pollen—a material which, though of plant origin, resembles animal matter somewhat in being very rich in protein. Finally, in Trogoderma, the adults tend to do little or no feeding at all and the larvae, in various species, make the transition to feeding on seeds of grasses and grains, which likewise represent concentrated proteinaceous material.

I have already referred to Dermestes as possessing the primitive habit of feeding on dryish animal matter in both larval and adult stages. By the general insect collector these beetles are generally encountered feeding on the carcasses of animals both large and small. Nor do the carcasses have to be particularly old to attract some of the species, though I suspect that on fresh carcasses, the beetles are feeding on the hide rather than on the soft tissues. As the carrion becomes progressively consumed and most of the other types of carrion insects have completed their life cycles or are searching for more tractable food elsewhere, Dermestes continues on until only dry hide and hair and bones remain. In addition to carcasses, other natural habitats in which hide beetles are found are the nests of birds and mammals, where the accumulated hair and feathers and the left-overs from the fish or other animal food brought in by the vertebrate owners of the nests furnish the means of sustenance for the beetles. Moreover in Europe a couple of species of Dermestes are known to develop in the nests of several species of gregarious caterpillars (Barber 1914), and the larder beetle (*Dermestes lardarius* L.) is recorded as developing in beehives.

With these habits, it is no wonder that, of the 56 known species of Dermestes, some 17 have become stored product pests. Of these the most important are the hide beetle, *Dermestes maculatus* DeG., and the larder beetle, *Dermestes lardarius* L., with the black larder beetle, *Dermestes ater* DeG., running a close third. All three are cosmopolitan in distribution.

The hide beetle, for instance, under favorable conditions of temperature and humidity may complete its life cycle in as short a time as six or seven weeks, but this may stretch out to as much as 33 weeks in the presence of low temperatures or to a period of several years in the absence of proper food. This ability of the larvae to withstand long periods of starvation is likewise possessed by numerous other of the stored product Dermestids. This means that the larvae can hide away in cracks and crevices or be transported in the absence of food in ships or in other materials, and probably accounts in important measure for the wide occurrence of some of the species.

The hide beetle infests a wide range of commodities with a high protein content such as bones, carcasses, skins and hides of all kinds, ham, bacon, cheese, dried fish, horn, feathers, furs, all stages of silkworms, bristles and glue of brushes, etc., etc. It was estimated in 1921 (Howard), that it was then damaging baled skins in the United States to the value of $1,000,000 a year; in 1929 (Clark) that it was causing £100,000 a year loss to the export trade in opossum skins in New Zealand, and in 1931 (Smit) that it was causing £350,000 a year loss to sheepskins in South Africa. Nor is the entire damage due to the feeding of the larvae and adults. The mature larvae bore a pupal chamber in almost any compact substance that happens to be at hand causing damage to ships and barges, wooden packing cases, the woodwork of factories and storerooms, and many other substances. It has even been known to bore through the lead fuses of telephone cables (Burke et al. 1922, pp. 3–4).

Finally, in one small particular, the hide beetle (and related species, like *Dermestes marmoratus* Say) play a useful role. Cultures of the beetles are maintained in certain museums, including ours at the University of Washington, and are employed to effect the cleaning of mammal skeletons, especially skulls. The insects eat away the dried muscle and cartilage and other tissues without injury to the underlying bony structures so efficiently that better museum specimens can be prepared in this way than in any other (Hardy 1945).

The larder beetle (*Dermestes lardarius* L.) has much the same history as the hide beetle. It attacks a long list of substances of animal origin and sometimes occurs in butcher shops and on hams. The most serious losses caused by this species probably occur on silkworm farms, where the silkworm cocoons and pupae are attacked (Hinton, p. 283). Silkworm cocoons in warehouses are also sometimes seriously damaged. In Germany, the larder beetle is sometimes found in pigeon lofts, where the larvae occasionally injure or even kill the young pigeons by boring into the wings.

I now turn to a consideration of the Dermestid carpet beetles of the genera Attagenus, Anthrenus, and Trogoderma. These insects are somewhat more specialized in their habits than are the hide and larder beetles, feeding for the most part on very dry substances of animal origin such as hair, feathers, horn, dead insects, etc., and, in the case of certain species of Trogoderma, dry seeds and grain. This dependence on animal food of most carpet beetles is not absolute, and there is credible testimony that (Hinton, p. 236) some species (*Attagenus piceus* Ol., *Anthrenus verbasci* L., *Trogoderma versicolor* Creutz, and *T. sternale* Jayne), while normally feeding on animal matter, are able to develop successfully when confined to a diet of grain or cereal products or seeds. The adults partake of the larval food either very slightly or not at all, feeding on the pollen and nectar of flowers, or, in the case of certain species of Trogoderma, simply do not feed.

The natural habitats of the carpet beetles are the places where the sorts of dried organic substances just mentioned tend to accumulate. The nests of birds, especially when they are shielded from the rain so that excessive moisture does not bring about too rapid decomposition, the nests of certain mammals, the nests of bees, of wasps, of spiders, and of gregarious caterpillars, the burrows of wood boring beetles, and, to a limited extent, under the bark of logs—all these and others are places where carpet beetle larvae are likely to find the food on which they can develop. Spencer (1948, p. 7), in British Columbia, reports finding the black carpet beetle (*Attagenus piceus* Ol.) most frequently under old horse or cow skeletons that are nearly dry and from which everything but shreds of tendons have been picked.

The eggs are usually laid in direct association with the prospective food and the larvae throughout their lives react negatively to light, so that they tend to keep hidden away. The humidity must be such as to keep the food in the dry condition to which the larvae are adapted. As with the hide and larder beetles, the rate of development is conditioned by the temperature and the availability of food, but in temperate regions the normal life cycle occupies about a year. The life cycle is, however, subject to rather extraordinary variation. At room temperatures in Wisconsin (Wodsedalek 1912) it was possible to obtain two and a fraction generations of *Trogoderma inclusum* LeG. (= *versicolor,* Hinton pars) in a single year, and in the Sudan the life cycle of the furniture carpet beetle (*Anthrenus vorax* Waterh.) may take as little as six weeks. On the other hand (Wodsedalek 1917), it was found that when larvae of *Trogoderma inclusum* LeC. (= *tarsale,* Wodsedalek) were deprived of food some of them survived for over five years (1,884 days) during which period they kept on shedding their skins and getting smaller and smaller. Larvae ⅓ inch long could be starved until they were only 1/25 inch long, about the size they were when they first emerged from the egg, and ⅛ inch larvae were starved until they were smaller than hatching size. Moreover, the larvae were capable of complete recuperation at any time when food once more became available, and some larvae survived alternate prolonged starving and feeding three distinct times. So far as I know, the remarkable capacity of these Trogoderma larvae to wax and wane with the food supply is without precedent, and suggests the way in which carpet beetle larvae are likely to be able to remain viable for long periods of time in unoccupied houses and warehouses.

When the larvae reach maturity, they pupate in the last larval skin, and the adults, after the last moult, remain in the last larval skin for from one day to two or three months, depending in part on the species. For a short time they remain negative to light, but eventually, at least in Attagenus and Anthrenus, they become positively phototrophic and fly away to flowers where they feed on pollen and nectar and mate. The final event in the life cycle is, then, for the fecundated females to search out, probably by means of their sense of smell, properly dry animal matter where the eggs are laid and another generation of larvae gets under way.

But the carpet beetle is nothing if not adaptable. We have seen how they can develop on food of plant origin if nothing else is available. They are also able to reproduce if deprived of the opportunity of a pollen meal so that individuals shut away in an insect box or trunk with proper food for the larvae can go on maturing, mating, and reproducing year after year, and one investigator (Spencer 1948, p. 8) kept a colony going for eleven years in this manner. But whether the insects would behave in this way if the adults were given the opportunity to seek out flowers is a question that I do not believe has so far been answered.

At this point a footnote is in order to call attention to some discrepant observations by J. E. Wodsedalek published in 1913, in which he reported collecting 800 specimens of *Anthrenus scrophulariae* L. on flowers in Madison, Wisconsin in 1911 and 1912. He dissected about 160 females from the collection without finding any eggs and maintained the rest in the presence of proper larval food without noting any mating or egg-laying or larvae, from which he concluded that the oviposition in this species is completed before the adults become positively phototrophic and seek out flowers. At the same time, Wodsedalek was maintaining viable cultures of the larvae and adults of the same species in which viable eggs were being laid by adults when they were still being repelled by light. On the other hand, Griswold and Greenwald (1941, p. 69) in 1941 reported beetles of this same species as laying viable eggs when collected from flowers. Wodsedalek's 1913 paper is listed neither by Hinton nor by Griswold and Greenwald in their bibliographies and his results remain unexplained. Perhaps some faulty technique was involved; perhaps there is an incorrect species identification somewhere; perhaps it is just further evidence of the tremendous variability of these beetles.

Moreover (Hinton, p. 379), there is definite evidence that *Trogoderma inclusum* LeC. (*versicolor* Hinton nec. Creutz, North American records) does not feed or become positively reactive to light until after the eggs have been laid, and it seems to be well established that the adults of khapra beetle (*Trogoderma granarium* Everts) never become positively phototrophic, but remain hidden away in cracks and crevices. Normally the khapra beetle adults are said to take little or no food and to mate soon after emergence. The species of Trogoderma are in general highly specialized and it may well be that the habit of the adults in some of the species eventually to become responsive to light and seek out flowers is an inherited hangover no longer of any significance in the life cycle of the insects but derived from ancestral forms that normally did feed on pollen before laying their eggs.

Beal (1954, p. 48) has given an interesting account of the mating behavior in several species of Trogoderma. Under laboratory conditions, the male becomes sexually stimulated only when his mouthparts come into contact with the setae on the back of the female. Thereupon he becomes intensively active and attempts to copulate. His first move is to place himself beside the female at such an angle (about 130°) that his genital region is in close proximity to that of the female. He then extrudes his genitalia and uses them in gently stroking the last dorsal segment of the female's abdomen. Under this stimulus, the female extrudes her ovipositor and copulation ensues. The entire process is usually completed in not more than 2½ minutes, but an active male was, on one occasion, observed to persist in his efforts to arouse the interest of an unresponsive female for more than three-quarters of an hour!

This, in synoptic form, is the biological background against which we must attempt to understand the carpet beetles. Carpet beetles are a pest because, due to our extensive use of wool and silk, our limited use of furs, and our predilection for natural history collections, we maintain in our houses and storehouses and museums materials suitable for their development, and because adjacent to and even within our buildings conditions exist that make the building up of carpet beetle populations possible.

Wool and the hair of furs are composed in important measure of an extremely refractory protein known as keratin and silk of another protein known as fibroin. These are what are known as naked-chain fibrous proteins, by which is meant that the molecules are in the form of long fibers which carry a very small proportion of their mass in the form of side chains. Such molecules are immune to the action of most protein-reducing enzymes and, hence, are completely indigestible by nearly all animals. The clothes moths and the carpet beetles are the only animals with the digestive equipment to break down such naked-chain fibrous protein molecules, in virtue of which capability Dr. Hugo Hartnack, in his "202 Common Household Pests" (p. 274), in 1939 proposed that we speak of them as "keratin pests." The details of the digestive process have not as yet been worked out in the carpet beetles. The webbing clothes moth Tineola, however, which utilizes about 47 per cent of the wool fabric ingested, possesses in its midgut a high hydrogen ion concentration and a relatively high concentration of sulfhydryl compounds (containing the radical —SH) which effect the reduction of the disulphide groups in the keratin molecule. The resulting molecule (keratein) is then readily attacked by the moth's proteinase enzymes, which are not very different from those possessed by numerous other insects (Roeder 1953, pp. 321–322; Fruton and Simmonds, Gen. Biochem. 1953, pp. 604–605).

There is some evidence that the larvae of the furniture carpet beetle (*Anthrenus vorax* Waterh.) cannot mature on a diet of pure raw wool, but that when the wool has been soaked in a horse-dung extract, they developed in record time (Hinton, p. 339). Apparently carpet beetles, like people, need their vitamines! A pure keratin diet is inadequate.

Moreover, damage to nylon fabric by the varied carpet beetle (*Anthrenus verbasci* L.) has been reported (Patton 1945). The larvae are unable to digest the nylon itself, but are attracted to it by the quality of the finish imparted to the fiber. If such is confirmed to be the case, it would seem that a finish might be devised that would not attract the beetles.

If our account of the later stages of the carpet beetle's life history is a valid one, materials susceptible to carpet beetle injury are probably infested in the main by their attractiveness to gravid flying females. Some infestation undoubtedly likewise results from the "overland" migration of larvae from previously infested situations. Accordingly, it is appropriate to consider conditions within or near the household or storehouse that promote the development of carpet beetles.

First, of course, there are the many kinds of flowers which prove attractive to the adults. In England, for instance, it is reported (Woodroffe and Southgate 1954, p. 576) that adults of the varied carpet beetle (*Anthrenus verbasci* L.)—our commonest species—occur almost exclusively on flowers within about 100 yards of buildings where they presumably have bred. Somebody someday will perhaps figure out how this flower-phase in the life cycle can be employed in controlling these pests. Elimination of flower gardens and/or extra tight screening against the reentry of the beetles both suggest themselves, but do not look very promising.

Next there are a number of carpet-beetle-breeding situations that develop in immediate proximity to the household. In England (Woodroffe 1953) it is believed that dry birds' nests are a prime source of household infestation by the varied carpet beetle. Dry nests are nests so protected from rain that bacterial and fungal growth does not bring about their rapid decomposition to a mass of humus, but decompose so slowly that they form a source of food for a more or less permanent population of those insects and mites that thrive on dried organic materials. Such nests, rare under natural conditions, are common under the eaves of houses, and in the vicinity of barns and sheds. From such nests there are listed 123 species of insects and mites and another investigator (S. Nordberg) in 1936 reported no less than 526 species of arthropods from birds' nests in Finland. Prominent in the fauna of the British nests are both the black carpet beetle (*Attagenus piceus* Ol.) and the varied carpet beetle (*Anthrenus verbasci* L.) and it is believed that nests in Britain are one of the most important means of household infestation.

In addition to birds' nests, bees' nests, wasps' nests, and spider webs are potent sources of carpet beetles. The bees' nests contain pollen, the cast skins of bee larvae, and occasionally dead larvae themselves. The wasps' nests and spider webs contain the dead remains of the insects which served as food for their original inhabitants. In California (Linsley 1944, p. 193) wasp and bee nests in and around buildings seem to be a far more important source of infestation by Anthrenus (*verbasci* L.) and Trogoderma (*sternale* Jayne) than are birds' nests.

Finally there are the accumulations of animal matter debris that accumulate in cracks and crevices, in attics and basements, and under porches. All these tend to add to the carpet beetle population.

It is not my purpose here to enter upon the control of carpet beetles to any appreciable extent. But I would urge the desirability of conducting control operations with imagination and insight. Do not forget that, necessary as chemical control is, it should in the long run be looked upon as a stopgap procedure to tide over an emergency. Ideal insect control, however rarely it is achieved, looks to other environmental factors that will keep the insects from becoming pests. The elimination of bird and insect and spider nests, where they are important sources of infestation, is such a move. The construction of buildings to discourage the nesting of birds is another. The elimination of cracks and crevices with crack filler or by paint or varnish looks in the same direction. Moreover, it must be kept in mind that, if material attractive to carpet beetles is merely sterilized by fumigation or residual spray, it will, when the effects of the chemical treatment have worn off, be susceptible to a new invasion of larvae.

In connection with this matter of chemical control, the importance of which I have no desire to discount, it is interesting to note the progress that has been made in the last half century. As late as 1902, the best remedy (Howard and Marlatt 1902, p. 60) the U. S. Department of Agriculture could devise against carpet beetles was "kerosene or benzine poured into the cracks and sprayed under the baseboards." By 1908 (Howard 1908) fumigation with carbon bisulphide, hydrocyanic acid gas, and sulphur dioxide had been added. By 1923 (Back 1923: 9–13) there had been added naphthalene, paradichlorobenzene, camphor, and carbon tetrachloride to the remedies suggested, and, of course, it was not until after 1945 that residual sprays such as DDT, chlordane, and lindane entered the picture.

So far I have been discussing the biology of carpet beetles in general. I now desire to direct your attention to some of the individual genera and species involved. If we eliminate the hide and larder beetles of the genus Dermestes, which I discussed earlier, there are some 650 species in more than 30 genera that come under the general head of carpet beetles. Of these only some 8 genera and 30 species are mentioned in Hinton's "Monograph of the Beetles Associated with Stored Products" and of these 8 genera and 30 species, only some 3 genera and 8 or 10 species can be rated as really major pests. Finally, in a region like the Pacific Northwest only 2 or 3 species seem to be of very general importance and, in fact, most of our difficulties center around the varied carpet beetle (*Anthrenus verbasci* L.). All of this is, of course, in line with something that emerges whenever one considers the biology of insects of economic importance. Of the vast number of species that exist in nature, only a trifling few have evolved the proper set of habits to make it possible for them to extend their activities so as to be of importance to man. Furthermore, a geographically isolated area like the Pacific Northwest is likely to be inhabited by only a sample of even the important species. As long as this remains the case, however, there is always the chance that species now absent may gain entry and become abundant. Thus the varied carpet beetle is creditably stated by Spencer (1948, p. 7) to have been absent from Vancouver, B. C. previous to 1936, where it is now a major household pest.

According to the National Pest Control Association Technical Release 5-54, the black carpet beetle (*Attagenus piceus* Ol.), "is generally recognized as the most destructive of the carpet beetles and may be the most destructive single pest of woolen fabrics in this country." The adults are distinguished from other carpet beetles by their uniform black color and the larvae by their elongate form and a conspicuous tuft of hairs at the rear end that is more than half as long as the rest of the body. It is a cosmopolitan insect and it has been suggested that it originated in the temperate region of the Old World (Fauvel 1889). It was first recorded in North America in Pennsylvania in 1806 (Griswold and Greenwald 1941, p. 9) and I have a female of what is apparently this species that was taken in Seattle in 1912. Within my experience it is not an important household pest in the Pacific Northwest, but I do have specimens from grain elevators in southeastern Washington (Pullman, Colton, and Whelon) taken in 1955 or 1956.

The black carpet beetle occurs in a long series of stored products of both animal and plant origin, but in many if not all of the instances in which the larvae are found in plant products they are feeding on the remains of other insects rather than on the product itself (Hinton, p. 318). "A large amount of the injury usually thought to be due to ordinary wear and tear of clothing or to defective manufacture is caused by it." The larvae frequently move around feeding just enough to cut a few threads here and there that start ravelings seldom associated with it.

A second important group of carpet beetles belongs to the genus Anthrenus. The adults of these beetles are black covered with black and white and yellow scales that form variegated patterns that have led to some of the species being broken up into color varieties, which have not so far been shown to have any biological significance. The larvae are rather oval in shape and toward the end of the abdomen have on each side a rather conspicuous tuft of obliquely backwardly directed hairs.

The cosmopolitan *Anthrenus verbasci* L. or varied carpet beetle is the most important carpet beetle to be found in the Pacific Northwest and California (Mallis 1960, p. 495). It is common in southern England where it is largely confined to suburban areas, avoiding both the metropolitan centers and the more rural districts (Woodroffe and Southgate 1954). Some of this prevalence is attributed to the liking of the beetles for dry bird nests and to their tendency to invade houses by way of the attics. Mallis (1960, p. 495) suggests that the occurrence of this species in the nests of bees and wasps in California indicates that it may be a native insect, but my feeling is that the species is in fact not native and has invaded these insect nests secondarily. The species has been known in North America since 1853 (Griswold and Greenwald). My earliest Seattle specimen dates from 1917, and, as previously noted (Spencer 1948, p. 7), it was not taken in Vancouver, B. C. until 1936. In Britain, the species was first taken in 1867, and I suggest that finding the species limited to situations within about 100 yards of buildings in suburban areas (Woodroffe and Southgate 1954) is a strong indication that the species is imported in Great Britain likewise. The varied carpet beetle (*Anthrenus verbasci* L.) is of especial interest to entomologists because "it is by far the most important pest of dried insect collections in temperate regions" (Hinton, p. 333).

In addition to *Anthrenus verbasci* L. I have three specimens of the furniture carpet beetle (*Anthrenus flavipes* LeC. = *vorax* Waterh., Barber 1951) taken in Seattle in January 1950 on material recently shipped from the east coast of the United States. The beetles are a bit larger than *verbasci* with more extensive white scales. It is a cosmopolitan species first recorded in the United States in 1911, capable of doing great injury to upholstered furniture and probably not established in the Northwest.

Finally, I have specimens of two species of Anthrenus from the Northwest that I suspect to be indigenous and that so far have not been taken in stored products: *Anthrenus casteneae* Melsh. from flowers in and near Seattle, and *Anthrenus lepidus* LeC. This latter species has been considered a synonym of the Old World *pimpinellae* F., but my specimens of *lepidus* usually occur on flowers so far from any buildings, as in the middle of the Grand Coulee, that I strongly suspect that it is a distinct indigenous species of little economic importance.

The third and last and most specialized of the three major genera of carpet beetles is Trogoderma. In most of the species the adults have the wing covers with variegated black and red markings and covered with black and white hairs. The larvae are elongate without the conspicuous tufts of hairs toward the apex of the abdomen that are so prominent in Anthrenus. The genus has been recently monographed by Dr. Beal (1954, 1956), and the differentiation of the species requires close study. Details of the color pattern, the nature of the sculpture of the surface of the cavity on the under side of the prothorax into which the antennae fit when the beetle is in repose, and the structure of the male genitalia are some of the characters involved in the separation of the species.

Beal (1956) recognizes 15 species from North America, of which 10 are definitely cited as occurring in stored products, although only 3 or 4 of the 10 are pests of any great importance. Five of the species are regarded as introduced. Nine of the 10 species from stored products have been found in both animal and plant material of which 5 occur in granaries (*angustum* Sol., *glabrum* Hbst., *inclusum* LeC., *simplex* Jayne, *sternale* Jayne). Of these, the cabinet beetle (*inclusum* LeC.) is not known to be able to subsist on grain alone. *Glabrum* Hbst. can live on grain alone and is a granary pest, but it is nowhere nearly as important as *granarium* and in nature is usually found feeding on dried insects. Finally, the khapra beetle (*Trogoderma granarium* Everts) seems to be a nearly or completely obligatory grain feeder.

In the Pacific Northwest, I have *simplex* Jayne and *glabrum* Hbst. from a grain elevator at Pullman (1952), *glabrum* Hbst. from stored food in Seattle (1940), and a series of *inclusum* LeC. from a dried milk plant in Lynden, Washington (1956). The National Pest Control Association Technical Release 6-54, May 17, 1954, deals with the problem of the cabinet carpet beetle (*Trogoderma inclusum* LeC. = *versicolor,* auct.) in milk drying plants.

The most specialized and one of the most important of the Trogoderma carpet beetles is the khapra beetle (*Trogoderma granarium* Everts), which I have been mentioning repeatedly. It is a species originally occurring in the warmer drier parts of the Old World, adapted in the larval stage to an exclusive diet of seeds and grain. The adults reproduce without feeding and apparently never fly away to flowers. It first began to occur in California about 1946, but it was mistaken for the less harmful black carpet beetle (*Attagenus piceus* Ol.) and was not recognized for the dangerous pest that it is until 1953, by which time it had spread to 24 counties in the southwestern United States and northern Mexico. I am credibly informed (R. W. Howe, personal communication) that the khapra beetle requires a warm dry climate and is not likely to spread northwards from California. Since 1953 large sums of money have been spent on the control and/or extermination of this granary pest.

The khapra beetle represents the apex of carpet beetle biology and with it our account of the Dermestidae may be brought to a close.

Literature

Back, E. A. 1923. Carpet beetles and their control. U. S. Dept. Agric. Farm. Bull. 1346, 14 pp.

Barber, H. S. 1914. The breeding place of *Dermestes elongatus* LeConte. Proc. Biol. Soc. Wash. *27:* 146–147.

—. 1951. Another name for the furniture carpet beetle. *5:* 44–45.

Beal, Richard S., Jr. 1954. Biology and taxonomy of the Nearctic species of Trogoderma (Coleoptera: Dermestidae). Univ. Cal. Publ. Ent. *10:* 35–102.

—. 1956. Synopsis of the economic species of Trogoderma occurring in the United States with descriptions of a new species (Coleoptera: Dermestidae). Ann. Ent. Soc. Amer. *49:* 559–566.

Burke, H. E., R. D. Hartman, and T. E. Snyder 1922. The lead-cable borer or "short-circuit beetle" in California. Bull. U. S. Dept. Agric. *1107:* 56 pp.

Clark, A. F. 1929. Insects affecting opossum skins in New Zealand. N. Z. Jour. Agric. *39*(4)*:* 260–261.

Fauvel, Albert. 1889. Liste des Coléoptéres communs a l'Europe et a l'Amerique du Nord. Rev. d'Ent. *8:* 92–174.

Fruton, Joseph S. and Sofia Simmonds. 1954. General Biochemistry. New York. 940 pp.

Griswold, Grace H. and Margaret Greenwald. 1941. Studies on the biology of four common carpet beetles. Cornell Univ. Agric. Exp. Sta. Mem. 240, 75 pp.

Hardy, Ross. 1945. Dermestid beetles for cleaning skulls and skeletons in small quantities. Turtox News *23:* 69–70.

Hartnack, Hugo. 1939. 202 common household pests of North America. Chicago. 319 pp.

Hinton, H. E. 1945. A monograph of the beetles associated with stored products. 443 pp.

Howard, L. O. 1908. The carpet beetle, or "buffalo moth" (*Anthrenus scrophulariae* L.). U. S. Dept. Agric. Bur. Ent. Circ. 5, rev. ed., 4 pp.

—. 1921. Report of the entomologist. Rep. Ent. U. S. 1920–21, 33 pp.

Howard, L. O. and C. L. Marlatt. 1902. The principal household insects of the United States. U. S. Dept. Agric. Bull. 4, N. S., rev. ed., pp. 1–99.

Linsley, E. Gorton. 1944. Natural sources, habitats, and reservoirs of insects associated with stored food products. Hilgardia *16:* 187–224.

Mallis, Arnold. 1960. Handbook of pest control. Third Ed. New York. 1132 pp.

Norberg, Sven. 1936. Biologisch-ökologische Untersuchungen über die Vogelnidicolen. Acta Zool. Fenn. *21:* 1–168.

Patton, R. L. 1945. Insect damage to nylon. Jour. Econ. Ent. *38:* 522–523.

Roeder, Kenneth D. (editor). 1953. Insect physiology. New York. 1100 pp.

Smit, B. 1931. Insect damage to hides and skins. Fmg. in S. Afr. 1931, 3 pp.

Spencer, G. J. 1948. Notes on some Dermestidae of British Columbia (Coleoptera). Proc. Ent. Soc. B. C. *44:* 6–9.

Wodsedalek, T. V. 1912. Life history and habits of *Trogoderma tarsale* (Melsh.), a museum pest. Ann. Ent. Soc. Amer. *5:* 367–382.

—. 1913. The reactions of certain Dermestidae to light in different periods in their life history. Jour. of Animal Behavior *3:* 61–64.

—. 1917. Five years starvation of larvae. Science *46:* 366–367.

Woodroffe, G. E. 1953. An ecological study of the insects and mites in the nests of certain birds in Britain. Bull. Ent. Res. *44:* 739–772.

Woodroffe, G. E. and B. J. Southgate. 1954. An investigation of the distribution and field habits of the varied carpet beetle, *Anthrenus verbasci* (L.) (Col., Dermestidae) in Britain, with comparative notes on *A. fuscus* Ol. and *A. museorum* (L.). Bull. Ent. Res. *45:* 575–583.

The Survey Course

A Graduate Student in Zoology

Survey courses in biology, especially those labeled "General Botany" or "Zoology" or "Animal World" or "Plants in Your Life," usually fail to enthuse the larval student. In view of the fact that the average freshman is a most impressionable animal, this is unfortunate. We have here, in a sense, an animal begging to be dissected; a bacterium longing to be parboiled; a freshman burning for knowledge. And we let him down by boring him *ad nauseam,* or even slightly beyond. Not that there are a million laughs beneath each anatomical fact, but even an amoeba should provoke an occasional smile.

Those registered for this fundamental work are usually faced by a completely impersonal group of instructors. Apparently neither professor nor graduate assistants notice the students who are lost in the stampede after class. A part of the problem lies in these scions of the academic world who would cram students with assorted bits of information while maintaining an air of detached apathy. The facts may be a necessary evil, but the apathy is a communicable disease.

The professor in charge of the course, who is certainly a likable chap, has what he considers a tough job. Anyone attempting to fill his lectern would agree. However, what his job lacks is prestige like more money, or fame, or a trip to the continent. At least, it hasn't the prestige of teaching advanced courses which requires a keen and penetrating mind. Therefore, the post goes to the staff member who: (1) has taught the course before, (2) has the lightest academic load, (3) does not exert much pull in the office, or (4) is primarily interested in research. In this position, who blames the professor?

The graduate student who conducts laboratory is not much more inspired. This budding scientist is research oriented, relentlessly pursuing scientific minutiae. Although his course work is important, research ability can make him or break him in his profession, so that teaching details are given little consideration. He has sympathy with the beginning students but cannot spare the time to contribute more than a kind word, if even that. When Botany 100 is over he rushes back to the flask boiling mysteriously on his desk, pours it into a prepared cup and sluices down his instant coffee. Muttering for effect, he dives back into his real work. At the first laboratory session he feels completely confident to present the laboratory material extemporaneously. In a few curt sentences he gives instructions on the goals of the laboratory work. The student is told: (1) that unless he is pretty dumb, he should have no trouble with the course; (2) that he should try not to have trouble; (3) that the course is tough; (4) that the grades will not be curved; (5) that in case of trouble he should see one of the graduate assistants whose office is located in the sub-basement of the white house two miles due west of the Administration Building. But wait! The student may see said assistant from 11:30 to 11:45 Wednesday or Friday, after 10:30 in the evening, or all day Christmas!

The brusqueness of the professor and rather calculated unavailability of the assistant are not likely to make the student feel welcome. The timeless nature of the course of study is an additional trial. Since the course was concocted by an able scientific mind, it is deemed educationally perfect through eternity. In fact, the student's father may have had the identical course 25 years or so before.

The professor usually makes little effort to bring any instructional tools into use during the lectures that might interest and motivate the students. It is plain to him that anything more than a few lop-sided slides or a patched motion picture is beneath the dignity of his calling.

In the laboratory, the student comes face to face with the same rats his parents used. Indeed he may find his father's initials punched into the viscera with a dissecting needle. The assistant will undoubtedly leave the laboratory whenever possible to escape the smells of formaldehyde and decay. In a sense, here is the testing ground for future biologists. These students will carry to the grave their impressions of that laboratory, and the girls will continue to cringe at the thought a decade or so hence.

Probably most insulting of all treatments during this basic course is the apparent lack of concern for the student as a person. Coupled with other unspeakable horrors, this is likely to produce no wave of nostalgia for "good old Bio I." The treatment is probably unprejudiced; the students are just one big herd, each with his number and section.

In no one is a feeling of enthusiasm or even mere liking engendered for the life sciences. Should an unwary student come into the course with any thought of making biology a major, every effort will be made, however unintentional, to discourage him. Those who had no such ambition will be absolutely certain that their forte lies elsewhere.

As biologists we have deep-seated feelings of respect for science—narrow minds it is sometimes said. Contrary to opinion, it is important to us to secure the good will and respect of the public and in particular of those who attempt to pass through our courses. We must attract a greater number of interested students for training and raise our standards drastically. Our basic survey courses would then become literally show windows. Only the most inspired instructors and assistants should be allowed to participate in this renaissance. Newer methods of teaching, greater numbers of motivational tools and spanking new laboratory methods should be employed. Individual work within the specified course outline should be encouraged. Closer relationships should be made possible between instructor and student, and stress should be laid on outside reading and research.

In short, those associated with biology at the college level must stop thinking in terms of the time-honored biology course. Bring on a modern design that will attract teeming numbers of enthusiastic students to what is our bread and butter, the survey course.

Enter, A Spiritual Leader!

E. A. SEAMAN*

WHAT DOES a big governmental department feel about the managing of natural resources on its properties? Does a bureaucracy have a conscience in the field of natural resources? Well, I am from the Washington scene. Therefore, I should, as a Washingtonian, have a viewpoint. I do, and I am here to express it. I believe there is a rapidly growing view in large departmental agencies that demonstrates that there is an active concern over the conservation of our natural resources. There is an awakening of a conscience which says: "We must be good stewards of the lands entrusted to our care."

General White, Chief of Staff of the U. S. Air Force, covered this awakening feeling along defense department lines in an article in the Saturday Evening Post, March 1958, when he said: "Isn't conservation really a defense effort in itself? Defense is more than planes and missiles to protect the country against an enemy attack. Part of the defense job is the safeguarding of the land, timber and waters, the fish and wildlife, the priceless natural resources which make this country of ours worth defending."

One fifth of our lands are federally owned and supervised. The management of our natural resources, then, is a big job—a real responsibility if we seriously carry the role of being good stewards.

One of the healthy signs noted in Washington is the fact that one of the larger federal agencies dedicated to conservation activities is at this time seriously revaluating its entire program, actually revaluating its reason or justification for existence. Concurrently, one of the leading private national conservation agencies is reorganizing (some disagree and say disorganizing!) its program drastically, and at the same time is revaluating its reason for existence. Because these two agencies are treating their reorganization confidentially at this time, I do not mention them by name. Long range program planning is popular and some Federal agencies are insisting on it. Such effort is oriented to the long range needs of the people who use these resources in their recreation. There appears to be a trend away from serving a restricted group—the multiple use concept. We find these agencies broadening their scope of concern better to meet the needs of "recreationists" (from the bird watcher to the sportsman) with interpretative programs to show people how really to learn and enjoy the out-of-doors. These two examples are but part of a trend to take stock of past actions preparatory to better action in the future.

---

* Mr. Seaman is the Advisor on Conservation of Natural Resources, USAF. This lecture was given to the Graduate Luncheon Club, Dept. of Natural Resources, University of Michigan, February 24, 1960.

The whole world is speeding up, yet coupled with this is the urge "personally" to slow down, to reflect, to revaluate and to look cautiously to the future.

Some say that federal agencies have been whipped into taking sharper stands on land stewardship. I believe, on the contrary, a widespread awakening of conservation workers in all areas, private, state, and federal, has brought about this improved view of the responsibility of stewardship. At this point I would define stewardship of lands simply as the wise management of lands entrusted to our care.

Now to get to the crux of our responsibility. Stewardship is not a mass matter; it is a personal consideration. This brings me to my greatest interest, which is people! The individual must not be ignored. He is the center of all creative thinking and the drive behind all trends.

Where do we stand in the light of years of conservation of natural resources? As we start the second half of the first century of conservation in America, I believe that our flower of conservation may bloom soon with the fruit to come not long from now. This is true also of the entire field of biology. I am reminded of the lecturer who was to address a group of hospital patients on the subject of "Responsibility," not knowing that most of his audience were mental patients. Three times he dramatically asked the question, "Why are we here?"—each time trying to stir the audience to the right pitch only to have a meek, quiet, but audible, reply from one schizophrenic in the audience: "Sir, we are here, because we are not all there!"

I feel that we are "all" here in conservation, nowadays, yet we lack one necessary element—a spiritual leader!

Seriously, the time is ripe for a national figure to spur us on to higher things in conservation, and indeed in the whole field of biology. We see so much mediocre research and mediocre management in the field. I feel at times that this is because we lack unity and the forceful guidance of a spiritual leader. I believe we are at a crisis in the development of conservation.

I have eight reasons why I feel we are at this stage.

First. As previously stated, we find going on actual, not theoretical, revaluation of our programs, our ideas, and our perspectives for the future in the field of conservation.

Second. A spiritual leader is overdue! We have had some over the years, but a great, outstanding leader has not appeared recently. We have had our Pinchot (and Teddy Roosevelt), Birge and Juday, Embody, Aldo Leopold, Ding Darling, Hugh Bennett, and Eschmeyer. I shall not compare or go further to illustrate. Each of these men played a key role in his own way, be it in forestry, in soils, in fisheries, in game, or in general conservation. The time is ripe for a spiritual leader who will represent the whole realm of conservation biology and thereby unify our thinking, our actions, our very attitudes in relation to the broad and basic needs of our society.

Sometimes it looks as if we are running out of adequate conservation leaders to whom to give recognition, except men who seem too young for such honor! This is a reflection, in part, on our ability to train leaders and use them to meet the many challenges that lie ahead.

Third. Conservation is becoming a layman's word. It is encouraging to see the newspapers putting articles on pollution on the front page. I noted that when Carol Heiss won her gold medal in the Winter Olympics Games this was a headline on the first page of the sports section, while a pollution article of national scope, which usually rated the second section, was on the front page!

Moreover, we note a more sincere interest in conservation on the part of our state legislators, and we see an awakening among members of our profession to the needs for stimulating concern about our natural resources among our representatives. The professional biologist is less afraid of "politics" and is learning to deal with the legislator more wisely.

Fourth. Some professional conservation and other biological societies are talking of uniting to hire executive secretaries. This is a healthy sign, although the foresters, the oldest in the business and most mature, reached this stage as early as 1930.

There is action to have national conservation groups unite with foreign societies to form stronger international groups, such as the International Union for Conservation of Nature and Natural Resources. Soon three world organizations will have come to America for the first time: the World Forestry Congress at Seattle in August, 1960, the International Soil Science Conference at Madison, Wisconsin, in August, and the International Limnological Congress, likewise at Madison, Wisconsin, in August 1962.

Fifth. All Federal agencies in Washington that should hire natural resources biologists are now doing so.

Sixth. Out of disorganization we see real organization emerging, based on thinking, and not merely on bureaucratic empire building.

After years of disunity, in January 1960 the mosquito control people actually sat down in a national committee with the fish and wildlife people to coordinate their work. Born was the National Mosquito Control—Fish and Wildlife Coordinating Committee.

Seventh. Consulting biology is here. Several full-time firms are operating across the country.

Eighth. A new breed of biologist-administrator is here. He has a new perspective, is clever, mature, and politically wise.

Now, how does the academic student fit into this picture?

The future calls for "slowing down." In this "speeded up" age we need men who can mature fast, without living fast! We need men who can take time to reflect, to revaluate all the time and not just occasionally. Especially do we need men who can "reread!"

An obscure individual in the mountains of West Virginia said in 1918, "We need a system of farm ponds on farms!" How far ahead of his time he was. We must keep dusting off our books. No matter if you are engaged in research, in management, or with administrative duties, you should continue to reread what the past workers wrote.

We often feel, for example, that the examination of fish scales for age determination is a new procedure. Actually, on rereading the literature, we learn that Van Leeuwenhoek, the pioneer miscroscopist of 300 years ago, in the eel-eating country of Holland discovered that eels had rings on their scales which he interpreted as indicating age.

Salaries are pitifully low. Mr. Milktoast never got a raise except automatically. We must demand higher salaries. Labor unions have gained salaries higher than ours for our plumber and our carpenter. As individuals and as organized professional societies we must demand and continue to demand higher salaries.

We have to know what we are up to! I had a boss a number of years ago who, when I asked him for my first vacation, said I should not take one. He said he had not taken one for 17 years and why should I? Two years ago I asked a midwestern leader in conservation work how he felt about the great increase of boats, trailers, and motors in his state. He replied: "What boats, motors, and trailers do you mean? How can they be affecting what I'm working on!" He had his hands in the water all those years, yet he failed to see the fish for the water!

Opportunities still exist. One should not accept the philosophy so often expressed in Washington that one can surely climb to the top, because older biologists die someday, creating vacancies. Give the older biologists competition! Strive to excel; not dog eat dog, but let the best man win. Do not let yourself retire mentally. Do not retire at all! Exploit your mind.

There is always room for new ideas. I was talking to a "hillbilly" in the mountains of West Virginia one day as both of us were watching the construction of the "big inch" pipe line. He commented, "Those Texans are smart people. Here they can pump gas and oil all the way from Texas through these mountains to New Jersey. But, them Texans are also dumb! I hear where they have a drought down there—and to think they ain't smart enough to pump water back!"

A leading nuclear physicist of our Department of Defense recently related to me how the physicist had been "catapulted" during recent years into great significance. He added, "I believe the biologist will be blasted into higher significance yet."

Another way to look at it is that we start with man, that is biology. The chemist, engineer, and physicist take him into space by providing the vehicles. But you have the biological factor of handling man in space and in his new home! The biologist is here to stay. Spiritual leadership will appear to give us a truer perspective not only of our profession but of biology's total responsibility to mankind.

Book Notices

Aristotle. JOHN HERMAN RANDALL, JR. 1960. Columbia University Press, New York, 309 pp. $5.00.

Ever since his rediscovery by biologists in the last century, Aristotle has been recognized as one of the three or four all time great zoologists. When, however, zoologists go to Aristotle's writings to find out at first hand what it is all about, they are likely to be repelled by the severity and technicality of his treatment. Nor will this book, important and penetrating as it is, pave the way for much easier entre. It is a book about a philosopher by a philosopher and couched in such terms that the more philosophical language one brings to its study, the more one will obtain from it.

Professor Randall regards Aristotle as the second of the two major philosophers of our civilization. Aristotle accepted the world and man at face value, without mysticism or troublesome complexity, as fully adapted to each other. The one is intelligible, the other has the capacity to understand it. Reality is, moreover, dynamic —the site of continuous change. Randall, moreover, agrees with those who see in Aristotle's zoology a central rather than a peripheral interest. Living things, like the rest of nature, are to be grasped in terms of their processes and functions. The final causes of biological phenomena are not to be understood in terms of the external purposes of a Deity. Aristotle had such a theistic world explicitly presented to him in Plato's *Timaeus* and he rejected it. In biology final causes, i.e., functions, are for Aristotle a necessary principle of intelligibility in terms of which organic processes and structures are to be understood.

Many expositors of Aristotle in all ages have endeavored to find in his works as much as possible that throws light on their current world, and Professor Randall is no exception. In addition to this, however, there is, of course, much that is dated. Aristotle's astronomy was pre-Copernican and his physics was pre-Gallilean, although, perhaps, not quite as absurd as some of Gallileo's contemporaries made it out to be. Aristotle's ethics was for an aristocrat and his politics for a city state. He is, however, one of the all time great figures in human history and Professor Randall has made an important contribution to understanding him and his contribution to our contemporary world.

Asa Gray 1810–1888. A. HUNTER DUPREE. 1959. Harvard University Press. Cambridge, Mass. 505 pp., 9 plates. $7.50.

Asa Gray was the leading American botanist of the third quarter of the last century. In this book, A. Hunter Dupree, Associate Professor of History at the University of California, presents a most skillfully and sympathetically constructed account of Gray's life. Born in the Mohawk Valley of New York State of Presbyterian parents, Gray early became the protegé of Dr. John Torrey, physician and botanist of New York City. Here, during most of his twenties, Gray subsisted on a pittance, specializing on systematic botany, getting out publications, and refusing steadfastly to be diverted into more general natural history studies. This policy paid off in 1842, when, at the age of 31, he was appointed Professor at Harvard University, a position that he held for over forty years. Dupree tells the whole story with great skill and insight—Gray's career as virtually a closet botanist through whose hands passed the bulk of the plants collected in North America for decades, his resolute Presbyterianism in the face of a predominantly Unitarian Harvard, his very moderate success as a teacher and lecturer against the brilliance of Agassiz, his acceptance of Darwinism at the same time that he insisted that natural selection was the mechanism of creation employed by a designing Deity, his rivalry with Agassiz in the setting of Harvard's intellectual life, his keen feeling for the Union during the Civil War, and his final perturbation with some of the innovations of the younger botanists. A charming and important book.

Pasteur and Modern Science. RENÉ DUBOR. 1960. Doubleday. Anchor Books, New York. 159 pp. 95¢.

A popularly written appreciation of a man who may, perhaps, be considered the greatest applied biologist. While no substitute for Vallery-Radot's full scale biography, it forms an excellent introduction. No bibliography.

The Autobiography of Science. Edited by FOREST RAY MOULTON and JUSTUS J. SCHIFFERES ed. 2. 1960. Doubleday & Co., Garden City, N. Y. 748 pp. $5.95.

This is a very perspicacious anthology of readings from great scientists to illustrate the history of science from the dawn of medicine in Egypt and Greece to the nuclear age. Over a hundred names are represented, so that the individual quotations are short. Especially noted are illuminating extracts from Hippocrates of Cos, Galileo's Sideral Messenger (1610, 13 pp.), Versalius' Preface to his *Anatomy of the Human Body* (1543, 11 pp.), Malthus' original (1798, 12 pages) *Essay on the Principle of Population,* Allardice's description of *the First Atomic Pile* (1946, 8 pp.), and Beadle's 1959 essay (10 pp.) on the role of DNA in heredity. Each reading is preceded by a paragraph of biographical and other information.

Theories of Scientific Method. The Renaissance through the Nineteenth Century. RALPH M. BLAKE, CURT J. DUCASSE, and EDWARD H. MADDEN. 1960. University of Washington Press, Seattle. 346 pp. $6.50.

This book considers the various theories of experimentation, induction and hypothesis and theory formation from the fifteenth century Occamists in Paris through Galileo, Bacon, Descartes, Hobbes, and Newton to Hume, Herschel, Whewell, Mill, Jevons, Peirce, and Wright. The book is of especial interest in connection with the various senses in which the term "hypothesis" has been used. It will interest all those concerned with the development of the basic logic of modern science.

Implications of Evolution. G. A. KERKUT. 1960. Pergamon Press, New York. 174 pp., 48 figs. $5.00.

The author of this book is a member of the Department of Physiology and Biochemistry at the University of Southampton and the editor of the latest revision (ed. 3) of Borradaile and Potts, *The Invertebrata.* The title of the present book almost completely conceals the nature of its contents. "A Critique of Phylogenetic Zoology" would have been a better but still not entirely exact title.

The thesis of *Implications of Evolution* is that there are so many and so diverse findings by different authors in the matter of phylogeny that the conclusions of any one author are to be taken as no more than rather tentative. Moreover, the suspicion is growing that numerous groups (e.g. Metazoa, Arthropoda, Amphibia, Reptilia, Mammalia) are not monophyletic but represent grades of structure, returning us in a measure to the Linnaean concept. Nowhere does Kerkut attempt to formulate what the principles governing phylogenetic studies should properly be, but he contents himself with reviewing various phylogenetic speculations from viruses, rickettsiae, and bacteria at the bottom to vertebrates at the top. The rather slender bases (e.g., Proterospongia, radioactive dating of rocks, comparative biochemistry, evolution of the horse) of some of our more luxuriant speculative growths are likewise explored. Haeckel's, Hyman's, Hadzi's and others' phylogenetic schemes come in for criticism.

Among the vertebrates Kerkut calls attention to Ordovician fragments of Agnatha and the fact that Osteichthyes are known from the early and middle Devonian whereas elasmobranches are known only from the middle-late Devonian. The chart (fig. 41) shows "fish" dating from the "Cambrian", amphibians from the lower Devonian, reptiles from the upper Devonian, and mammals from the upper "Carboniferous".

In the matter of the evolution of the elephants Kerkut quotes Romer that "in almost no instance is any known form considered to be a descendant from any other known form; every subordinate grouping is assumed to have sprung, quite separately and usually without known intermediate stage, from hypothetical common ancestors in the Early Eocene or Late Cretaceous".

This is an important work. It warns of the pitfalls in the path of all those (textbook writers, lecturers, taxonomists) who would engage in making phylogenetic constructs. The author betrays no slightest skepticism of the actuality of evolution; but he suggests that it occurred so long ago, the geological record is so incomplete, and the comparative anatomy, physiology, and biochemistry of living forms so incompletely investigated that conclusions are most uncertain. Full bibliography.

Evolution: Process and Product. EDWARD O. DODSON. 1960. Reinhold Publishing Corp., New York. 352 pp., 113 figs. $5.75 (college edition); $6.90 (trade edition).

This is a revised edition of *A Textbook of Evolution* first issued in 1952. It is a broadly conceived book in which nearly all aspects of organic evolution are adequately considered: its historical development; its distributional, morphological, and paleontological evidence, its phylogenetic implications; and its cytological, genetic, and population-study basis. Moreover, the book is written so that persons without previous knowledge of biology can read most parts of it with profit. Literature citations conclude each chapter, but occasional references are noted (e.g., Benson, 1933 on p. 241 and the long quotation from Zuckerman on p. 197) which are not completed.

Especially interesting is Dodson's suggestion (pp. 82–84) of an Agnostic Period (1903 to 1935) in the modern study of evolution, the period during which the findings of genetics appeared not to confirm the occurrence of the numerous minute heritable variations which natural selection required for its operation.

It is, perhaps, carping to find flaws in so excellent a book. The reviewer does note, however, the nearly complete lack of reference to insects and any account of man's mental and cultural as opposed to his morphological evolution. There is the unfortunate reference (p. 9) to Malthus' "Essay on the Principle of Population" as "Malthus on Population". Darwin used the 6th edition of 1826. The first edition of Darwin's own great book "On the Origin of Species . . ." is correctly cited and dated (p. 13), but the "Modern Library, New York" is given as publisher! The Modern Library reprint of Darwin's book was of the extensively modified 6th edition of 1872. It is suggested that authors and editors alike should take care to check carefully the references to reprints of books, both famous and otherwise. Scholarship would seem to be best served by a precise reference to original date and publisher and/or the original date and publisher of the revision, plus a reference to the precise reprint used. The same remark applies of Dodson's 1897 reference to Darwin's "Life and Letters." This book was originally issued in three volumes in 1887, by John Murray, London, and subsequently reset in a two volume format with completely new pagination!

The Mechanism of Evolution. W. H. DOWDESWELL. 1960. Harper Torchbooks, New York. 115 pp., 25 figs. 95¢.

This is an elementary very readable account of contemporary studies on evolution, first published in 1955 with a second edition in 1958. It seems well adapted for persons with little or no previous biological knowledge but is specialized enough so that someone more advanced might go to it with considerable profit for a glimpse of current evolutionary thinking.

The author is in error in stating (p. 7–8) that Malthus' *Essay on Population* appeared while Darwin was in South America. In reality, Malthus' book was published first in 1798 with a greatly enlarged second edition in 1803, a sixth and last edition in 1826.

A very attractive book.

Natural Selection and Heredity. P. M. SHEPPARD. 1960. Harper Torchbooks, New York. 209 pp., 8 figs. $1.35.

The hard cover edition of this book was reviewed in the BIOLOGIST for December, 1959, p. 35. An important book.

Principles of Genetics. ELDON J. GARDNER. 1960. John Wiley & Sons, New York. 366 pp., illus. $7.50.

Principles of Plant Breeding. R. W. ALLARD. 1960. John Wiley & Sons, New York. 485 pp., illus. $9.00.

Behavior Genetics. JOHN L. FULLER and W. ROBERT THOMPSON. John Wiley & Sons, New York. 396 pp., illus.

Principles of Human Genetics. ed. 2. CURT STERN. W. H. Freeman & Co., San Francisco. 753 pp., 265 figs. $9.50.

The first of these four books on heredity is an introductory survey for college students taking their first course. It gives broad coverage from genetics' historical origins and cytological bases through its mathematical refinements, population studies, and applications in human affairs and agriculture. There are 16 pleasing portraits of important contributors to our understanding of heredity. Literature references and problems conclude most of the 18 chapters. A good glossary would have been helpful.

The second book concentrates on those aspects of genetics involved in breeding and improving agricultural plants. It is concerned especially with explaining those procedures that have been useful in the improvement of species of economic importance. This is accompanied by full explanations of the biological and statistical principles involved with examples drawn from various cultivated plants. It is outside the design of the book to give a species by species account of cultivated plants. Bibliographical references follow each chapter and there is an eight page glossary, which, however, missed certain terms, e.g., "nicking", zygotene, pachytene, diplotene. The book is primarily written for undergraduate students of agriculture.

The third book on *Behavior Genetics* treats at length of the hereditary factor in the behavior of animals and man and the methods involved in its investigation. Full attention is given to the underlying principles so that the book can be followed by persons without specialized preparation in genetics. In general, modern genetics is reported as confirming the nineteenth century opinions of such men as Darwin and Galton that heredity plays a vital role in the inheritance of behavior and "instincts" in lower animals and of intellectual abilities and "intelligence" in man. The old dichotomy of heredity and environment is, however, deemphasized, since it is now seen that every potentiality requires an environment to bring it to fruition and every environment requires adequate potentialities to work on. The book concludes with a 34 page bibliography.

The last book on the *Principles of Human Genetics* is the second expanded edition of a book originally published in 1949. It turns the powerful methods of modern genetics on the science of man, giving full treatment to the many aspects of this subject, always with adequate coverage of underlying principles. Literature citations conclude each chapter.

These are a notable quartet of books, any one of which may be consulted in confidence depending on the aspect of genetics in which the reader is interested.

Aspects of the Origin of Life. Edited by M. FLORKIN. 1960. Pergamon Press, New York. 199 pp., illus. $5.00.

This is a selection of 20 of the papers contained in the larger 691 page volume on *The Origin of Life* reviewed in the previous number of *The Biologist*. None of the papers in French or German printed in the previous volume are here included.

Six Days or Forever? RAY GINGER. 1960. New American Library, New York. Signet Books. 224 pp. 50¢.

This is a day-by-day account of the trial of Tennessee versus John Thomas Scopes in Dayton, Tennessee in 1925 for teaching "that man has descended from a lower order of animals." The previous careers of fundamentalist and three-time candidate for president, William Jennings Bryan, and liberal, atheist, labor and criminal lawyer, Clarence Darrow, are set forth as background for their culminating clash at Dayton. Darrow was never allowed to introduce his expert witnesses and Scopes was convicted only to have his conviction set aside by the Supreme Court of Tennessee because of the incorrect manner in which his fine had been assessed! The State had meanwhile seen the light and, even though the law was never repealed, failed to arraign Scopes a second time. The "pay-off", in reality, however, was that after tthe trial Scopes confessed to a confidant that he was never really guilty after all, that he had been absent from school during the week when the particular chapter of Hunter's *Civic Biology* on evolution was being covered! This book was first published in 1958.

A Structure of Science. JOSEPH H. SIMONS. 1960. Philosophical Library, New York. 269 pp. $4.75.

The author of this book, in Part I, in easy flowing simple language tells us what he thinks science is all about. The concepts of physical science are set forth in Part II. In Part III, under the title of "A Tidy Universe," the author objects to the concept of the expanding universe and sets forth an alternative explanation for the red shift in the spectra of the galaxies. The reviewer must leave to others the evaluation of Mr. Simons' reasoning.

Problems of Life. An Evaluation of Modern Biological and Scientific Thought. LUDWIG VON BERTALANFFY. 1960. Harper Torchbooks, New York. 216 pp. $1.35.

First published in 1952, this book argues for an organismic concept of living organisms. It is written at a fairly technical level.

Dictionary of Word Roots and Combining Forms, Compiled from the Greek, Latin, and other Languages, with Special Reference to Biological Terms and Scientific Names. DONALD J. BORROR. 1960. N-P Publications, Palo Alto. 134 pp. $2.00.

In addition to a dictionary of combining roots, this book contains rules for pronouncing scientific names, common sense suggestions for the formulation of new scientific names, rules for transliterating Greek words, a brief English-Greek-Latin vocabulary of common combining forms, and an index of common suffixes. A useful book.

Biology, A Basic Science. ed 2. ELWOOD D. HEISS and RICHARD H. LAPE. 1961. D. Van Nostrand Co., Princeton, N. J. 689 pp., illus. $5.56.

An attractive text for use in secondary school biology.

Classics in Biology. A Course of Selected Readings by Authorities. Edited by S. ZUCKERMAN. 1960. Philosophical Library, New York. 351 pp. $6.00.

This is a series of brief readings, from the writings of eminent biologists, designed to introduce the reader to the problems of modern biology and some of its medical applications. Thirty-one of the 36 authors quoted are British and 29 of them lived into the twentieth century. T. H. Huxley, Louis Pasteur, J. D. Bernal, Charles Darwin, Gregor Mendel, E. B. Ford, Lord Lister, Julian Huxley, and D'Arcy Wentworth Thompson are among the men represented. An appendix gives brief biographical information about the men quoted.

Attenuated Infection. The Germ Theory in Contemporary Perspective. HAROLD J. SIMON. 1960. Lippincott, Philadelphia. 349 pp., 15 illus. $10.00.

This is a study of the germ theory of disease in the light of modern evolutionary theory. The thesis is that acute reaction on the part of an organism to parasite invasion is evidence of maladaptation and that the normal effect of natural selection is to produce a relationship in which host and invading organism live together in harmony to the advantage of both parties. This theory is studied in depth with a full consideration of the relevant data derived from the current knowledge of plant, animal, and human diseases, and a consideration of the circumstances that reduce dangerous invading organisms to an innocuous condition. The suggestion that emerges is that genetic factors are of paramount importance in effecting this coadaptation. The author concludes with the hope that the realization that peaceful coexistence is the rule in nature means that war among humans is not biologically inevitable but runs counter to the general pattern of biologic interactions. A profound and important book. A concluding bibliography of 294 titles.

Biochemistry of Plants and Animals. An Introduction. M. FRANK MALLETTE, PAUL M. ALTHOUSE, and CARL O. CLAGETT. 1960. Wiley, New York. 552 pp., illus. $8.50.

This is an introduction to biochemistry for undergraduates with some training in organic chemistry and with some emphasis on the nutrition of plants and farm animals of interest to students of agriculture. The rapidly growing knowledge of present day biochemistry is emphasized by the notation "from information available in 1959" or its equivalent attached to several of the diagrams of metabolic pathways. As is usual in such texts, no effort is made to explain the techniques or evidence involved in reaching the conclusions presented. Selected readings conclude each chapter.

Experimental Biochemistry. A Laboratory Manual. GERALD LITWACK. 1960. Wiley, New York. 313 pp., 71 figs.

An outline of 42 experiments for an introductory course at the undergraduate or beginning graduate level. Bibliography.

Lipide Metabolism. Edited by KONRAD BLOCH. 1960. Weley, New York. 411 pp. $10.50.

A collection of eight chapters by thirteen authors on aspects of the intermediary metabolism of lipides. With Hanahan's *Lipide Chemistry* (Wiley, New York, 1960) it completes a two volume set on the principles and concepts involved in the study of lipides. Extensive bibliographies.

International Review of Cytology. Volume IX. Edited by G. H. BOURNE and J. F. DANIELLI. 1960. Academic Press, New York. 424 pp., illus.

Various aspects of the work being done in cytology are reviewed annually by prominent investigators. Volume IX consists of nine reviews: "The Influence of Cultural Conditions on Bacterial Cytology" (76 pp.), "Organizational Patterns within Chromosomes" (51 pp.), "Enzymic Processes in Cells" (57 pp.), "The Adhesion of Cells" (39 pp.), "Physiological and Pathological Changes in Mitochondrial Morphology" (65 pp.), "The Study of Drug Effects at the Cytological Level" (11 pp.), "Histochemistry of Lipids in Oogenesis" (15 pp.), "Cyto-Embryology of Echinoderms and Amphibia" (47 pp.), "The Cytochemistry of Nonenzyme Proteins" (24 pp.). It also includes complete author and subject indexes. An excellent reference for work currently being done in the field of cytology.—BILLY G. LEWIS.

Aquatic Phycomycetes. F. K. SPARROW. 1960. University of Michigan Press, Ann Arbor. 2nd Revised Edition. xxv + 1187 pp., 91 figs.

For many years the first edition of Dr. Sparrow's "Aquatic Phycomycetes" (1943, reprinted 1945) has served as an indispensable source of information to all biologists interested in aquatic fungi; indeed, it was the only comprehensive modern source of information pertaining to the aquatic Phycomycetes. When the edition went out of print some years ago and demand for the book continued unabated, a second edition became inevitable. Those who have been hoping to see the first edition expanded and brought up to date will find their hopes fully satisfied. The large number of publications on aquatic Phycomycetes that have appeared in the interval between 1943 and 1960 have been examined, and the new information they furnish incorporated into the text of the new edition. The result is a substantially larger volume; 1187 pages as compared with 785 for the first edition, and 22 additional figures. Mere increase in size, however, is only an indirect measure of the usefulness of the book. The service that Dr. Sparrow has performed for biologists in general and limnologists, algologists and mycologists in particular, in critically evaluating the recent work on aquatic Phycomycetes and presenting a comprehensive picture of the present state of knowledge of these organisms, is sure to be appreciated by anyone who has attempted to keep up with the ever-increasing literature on the subject.

In general outline, the second edition follows the first closely. The scheme of classification is essentially the same, as is also the sequence of chapters. Some of the more noteworthy innovations are as follows: The order Blastocladiales now contains three families instead of the single family Blastocladiaceae. Of the two additional families Coelomomycetaceae and Catenariaceae, the former was not included in the first edition, and the latter was treated as a subfamily of the Cladochytriaceae in the order Chytridiales. The anteriorly uniflagellate Chytrid-like fungi, included in the first edition in three genera of the single family Hyphochytriaceae, are now considerably increased in number and constitute the order Hyphochytriales, with three families and a total of six genera. A key to the aquatic species of *Pythium* and *Phytoora* has been included —a most useful addition, in view of the frequency with which species of *Pythium* are encountered when one is searching for other aquatic Phycomycetes. Although in the second as in the first edition only a key to the genera of Saprolegniaceae is included, Dr. Sparrow has added a list of all taxa described in this family since the publication of the monographs of Coker (1923) and of Coker and Matthews (1937). This information will be very useful to those interested in the "water molds", and should save them much time spent in searching through a number of journals many of which are not readily available. A chapter on the conidial aquatic Phycomycetes belonging to the genus *Ancylistes* (Entomophthorales) has been added, and represents the first treatment of this genus since Berdan's account of it in 1938. A relatively small number of new taxa are described, considering the scope of the work. There are five new species (*Rhizidium chitinophilum, Chytridium melosirae, Rozella canterae, Rhizophydium canterae* and *R. karlingii,* all in the Chytridiales), and three new genera, *Karlingiomyces* (Chytridiales), *Canteriomyces* (Hyphochytriales) and *Rhizidiomycopsis* (Hyphochytriales). Finally, mention should be made of the greatly improved form of the list of substrata, a most welcome innovation, that will enable one to tell at a glance just what fungi have been reported on a particular substratum.

The physical characteristics of the second edition are excellent: the quality of paper, type and line drawings is very good indeed, and the binding is both stout and attractive, promising to stand up well under constant use, a necessary attribute in a volume of this size. Errors are almost non-existent, a remarkable feat in the production of such a large and complex book. The text is written in Dr. Sparrow's characteristically concise and forthright style, that might well serve as a model for scientific writing. In short, both he and the University of Michigan Press are to be congratulated for producing a volume that will serve for many years to come as the standard reference work on aquatic Phycomycetes.—Daniel E. Stuntz.

Aquatic Plants of the Pacific Northwest with Vegetative Keys. ALBERT N. STEWART, LA REA DENNIS, and HELEN M. GILKEY. 1960. Oregon State College, Corvallis. 184 pp., 179 figs. $2.50 paper; $4.50 cloth.

This is a key based on vegetative characters to the species of aquatic Bryophyta, Pteridophyta, and Spermatophyta occuring in Oregon, Washington, British Columbia, and Alaska. An effort has been made to include all true aquatics as well as other "species whose life cycle includes some stage that requires either the saturation of the substrate with water or the presence of an ambient aqueous medium." There is only the briefest sort of an introduction, but the book concludes with a glossary, a bibliography, and an extensive index. The figures illustrate the vegetative characters of many of the species described.

Flora of the British Isles Illustrations. Part II. Rosaceae-Polemoniaceae. A. R. CLAPHAM, T. G. TUTIN, and E. F. WARBURG. Drawings by SYBIL J. ROLES. 1960. Cambridge University Press, New York. 119 pp. figs. 553–1012. $5.00.

The Cambridge *Flora* illustrations are designed to provide a comprehensive series of line drawings, small enough for eight to be on each two-page spread and cheap to reproduce. The drawings give the detail necessary for identification, using easily grasped conventions in the simplified rendering of parts (e.g. the hairs on a stem), and aiming at an accurate general impression of the whole living plant together with a selection of detailed features so as to assist with the appreciation of technical descriptions. Over half (287) of the species figured carry Linnaean names.

The Anatomy of Plants. P. FONTQUER. 1960. Harper & Bros., New York. 128 pp. 173 figs. $1.75.

This book, translated from the Spanish by D. H. R. Newton, is a very compact account of the anatomy of seed plants.

Notes on Microscopical Technique for Zoologists. C. F. A. PANTIN. 1959. Cambridge University Press, New York. 79 pp., 9 figs. $1.75 (paper ed.).

This book is designed to guide the student through the embarrassing number of methods offered to him by current handbooks of microscopy and histology. A selection of standard methods is given set out in a form suitable for use on the laboratory bench. Many bibliographical references to further details are likewise cited. Notes on such matters as drawing, graphic reconstruction, micrometry, and special methods for Protozoa, and an index conclude the book.

Proceedings of the Centenary and Bicentenary Congress of Biology Singapore, December 2–9, 1958. Papers Delivered in the University of Malaya in Commemoration of the Works of Darwin, Wallace and Linnaeus. Edited by R. D. PURCHON. 1960. University of Malaya Press, Singapore. 333 pp. $13.50 in Malaya only.

This is a collection of 44 papers and 18 abstracts in the fields of Evolution, Parasitology, Entomology, Zoogeography, Terrestrial and Freshwater Ecology, Genetics, Anthropology, Systematics, and Botany. Many of the papers are summary studies rather than original research, but several new species of Flagellata from Malaya are noted and figured by G. A. Prowse. Nearly all the papers relate to the Malayan region or nearby areas. The titles of the papers are too numerous to note in detail here, but are sufficiently important and interesting so that every biological library should possess a copy.

Ecology of Inland Waters and Estuaries. GEORGE K. REID. 1960. Reinhold, New York. 375 pp., illus. $7.80.

This is a treatise on the basic principles and theories involved in limnology. The first five-eighths (210 pages) of the book treat of the physical elements of the environment: the geological and physiographical factors involved in the formation of bodies of water, the nature of water, and of solar radiation. By the time we get to dissolved gases and solids, the activities of organisms make themselves apparent. About 50 pages are devoted to a very general survey of the plants and animals involved. Twenty-five pages treat of the general principles involved in population biology and a concluding 50 pages treat of aquatic communities. The effort has been to provide an assemblage of basic materials in the light of which individual aquatic communities and populations can be considered. Bibliography.

Stochastic Population Models in Ecology and Epidemiology. M. S. BARTLETT. 1960. Wiley, New York. 90 pp. $2.00.

This book sets forth the mathematics of stochastic or probabilistic population models and recent allied statistical developments for biometricians and theoretically minded ecologists. Bibliography.

Molluscs. J. E. MORTON. 1960. Harper Torchbooks, New York. 232 pp., 23 figs. $1.40.

This book, first published in 1958, surveys the molluscs from the points of view of external form and habits, respiration, feeding and digestion, circulation and excretion, sex and reproduction, nervous system and behavior, and classification. The emphasis throughout is on functional morphology and evolution at a relatively advanced level. The illustrations are small and unsatisfactory. In a book dealing, as this one does, in such exhaustive fashion, with the almost endless forms and adaptations assumed by the members of the second largest phylum of animals it is unfortunate that no attempt is made to define the major groups mentioned. To be most effective, moreover, the book should contain numerous large detailed figures, in color where necessary, of the forms and structures discussed. But this might well make it prohibitively costly! As it is, the book will appeal mostly to advanced students who will be able to supply the background knowledge required of the many families and genera mentioned. For such, the book will be very rewarding.

Treatise on Invertebrate Paleontology. Part O. Arthropoda 1. Edited by RAYMOND C. MOORE. 1959. Geological Society of America and University of Kansas Press. 560 pp., 415 figs. $10.00.

The book is noted to call attention to the authoritative 24-volume set now in course of publication of which this book is a part. To date volumes on Radiolarians and Tintinines (Part D), Porifera (Part E), Coelenterata (Part F), Bryozoa (Part G), Ammonoid Cephalopods (Part L), Chilicerate and Pycnogonid Arthropods (Part P), and Graptolithina (Part V) have appeared. The present volume, the collaborative product of 18 authors, treats of the Onychophora (5 pp.), the 9 orders of the very strange Trilobitoidea (15 pp.), and the Trilobita (523 pp.).

The trilobites are, of course, an important and amazing group of animals. Now know in 1500 genera and 10,000 species, they occur over a period of some 250 million years from the Lower Cambrian to the Permian. The rise and fall of the class is shown by the following tabulation of families known from each period:

Lower Cambrian	29 families
Middle Cambrian	48 families
Upper Cambrian	62 families
Lower Ordovician	51 families
Middle Ordovician	37 families
Upper Ordovician	33 families
Lower Silurian	16 families
Middle Silurian	16 families

Upper Silurian	15 families
Lower Devonian	14 families
Middle Devonian	14 families
Upper Devonian	6 families
Mississippian	4 families
Pennsylvanian	4 families
Permian	2 families

After a 133 page introduction to "trilobitology" by H. J. Harrington, the 141 families follow, treated to the genus level, and illustrated by innumerable superb figures. I am sure that a taxonomist of any persuasion, as he leafs through the five hundred pages of this text, will be lost in wonder and admiration at the amazing variety of form and structure that will pass before his eyes.

With only one aspect of this splendid *Treatise* does the reviewer dissent. He dislikes forcing the uniform endings "-ida" and "-ina" on all order and suborder names! Are we to abide the corruption of such classical Linnaean names as "Coleoptera", "Diptera", "Hymenoptera", and "Lepidoptera" that this will entail?

Guide to the Study of the Anatomy of the Shark, Necturus, and the Cat. ed. 3. SAMUEL EDDY, CLARENCE P. OLIVER, and JOHN P. TURNER. 1960. John Wiley & Sons, New York. 141 pp., 24 figs. $3.50.

A dissection manual for a one-quarter course in dissection in the comparative vertebrate anatomy. No drawings are required of the students using the book.

THE BIOLOGIST has no paid field representatives, carries no commercial advertising outside the honor fraternity field, and cannot be obtained through any magazine groups.

ALUMNI members of PHI SIGMA, as well as anyone else interested in our publication, are welcome to subscribe as indicated below.

Subscription Blank

Detach this form and fill out order. Mail with check or money order made payable to PHI SIGMA SOCIETY.

Date____________________

To: DR. F. S. ORCUTT
Executive Sec.-Treas.
Phi Sigma Society
Hillcrest Drive
Blacksburg, Virginia

I am enclosing $_______ for my subscription to THE BIOLOGIST for the term checked below:

☐ 1 year: $1.50
☐ 2 years: 2.75
☐ 3 years: 4.00
☐ 5 years: 6.00
☐ 10 years: 10.00
☐ 25 years: 15.00
☐ Life Sub.: 25.00

Name____

Address______________________________________

CHAPTERS FOUNDED

ALPHA—Ohio State University, Columbus, Ohio, 17 March 1915.

BETA—University of Michigan, Ann Arbor, Michigan, 3 June 1916.

GAMMA—North Dakota Agricultural College, Fargo, North Dakota (1916).

DELTA—University of Maine, Orono, Maine, 27 January 1917.

EPSILON—University of Denver, Denver, Colorado, 5 March 1917.

ZETA—University of Wisconsin, Madison, Wisconsin, 30 May 1917.

ETA—University of Akron, Akron, Ohio, 20 April 1921.

THETA—Michigan State College, Lansing, Michigan, 9 April 1921.

IOTA—Washington University, St. Louis, Missouri, 28 May 1921.

KAPPA—University of Kansas, Lawrence, Kansas, 31 May 1921.

LAMBDA—University of Montana, Missoula, Montana, 4 May 1921.

MU—University of California, Berkeley, California, 27 April 1922.

NU—Washington and Jefferson College, Washington, Pennsylvania, 11 May 1922.

XI—University of Nebraska, Lincoln, Nebraska, 3 May 1924.

OMICRON—University of North Dakota, Grand Forks, North Dakota, 26 May 1924.

PI—Emory University, Georgia, 3 January 1925.

RHO—University of Illinois, Urbana, Illinois, 28 March 1925.

SIGMA—University of Florida, Gainesville, Florida, 4 December 1925.

TAU—Duke University, Durham, North Carolina, 4 March 1926.

UPSILON—Miami University, Oxford, Ohio, 7 May 1926.

PHI—University of New Hampshire, Durham, New Hampshire, 21 May 1926.

CHI—Montana State College, Bozeman, Montana, 11 February 1927.

PSI—University of Washington, Seattle, Washington, 7 April 1928.

OMEGA—University of Oklahoma, Norman, Oklahoma, 24 March 1928.

ALPHA ALPHA—University of Southern California, Los Angeles, California, 17 May 1928.

ALPHA BETA—Mount Union College, Alliance, Ohio, 17 May 1928.

ALPHA GAMMA—University of South Dakota, Vermillion, South Dakota, 15 May 1928.

ALPHA DELTA—Lawrence College, Appleton Wisconsin, 17 March 1929.

ALPHA EPSILON—University of Pittsburgh, Pittsburgh, Pennsylvania, 23 March 1929.

ALPHA ZETA—College of William and Mary, Williamsburg, Virginia, 19 April 1930.

ALPHA ETA—Oklahoma State University, Stillwater, Oklahoma, 13 March 1930.

ALPHA THETA—State College of Washington, Pullman, Washington, May 1930.

ALPHA IOTA—Bucknell University, Lewisburg, Pennsylvania, 9 January 1932.

ALPHA KAPPA—Hunter College, New York City, 8 January 1932.

ALPHA LAMBDA—University of Utah, Salt Lake City, Utah, 13 February 1932.

ALPHA MU—University and State College of Oregon, Eugene-Portland-Corvallis, Oregon, 18 November 1933.

ALPHA NU—University of New Mexico, Albuquerque, New Mexico, 21 April 1935.

ALPHA XI—University of Rhode Island, Kingston, Rhode Island, 17 May 1935.

ALPHA OMICRON—Marquette University, Milwaukee, Wisconsin, 18 June 1938.

ALPHA PI—University of Colorado, Boulder, Colorado, 24 May 1941.

ALPHA RHO—University of Arkansas, Fayetteville, Arkansas, 23 May 1945.

ALPHA SIGMA—University of Texas, Austin, Texas, 2 February 1946.

ALPHA TAU—National University of Mexico, Mexico, D.F., 7 April 1947.

ALPHA UPSILON—University of California at Los Angeles, California, 17 May 1947.

ALPHA PHI—College of Puget Sound, Tacoma, Washington, 28 February 1948.

ALPHA CHI—University of the Philippines, Manila, Luzon, P.I., 12 March 1949.

ALPHA PSI—Virginia Polytechnic Institute, Blacksburg, Virginia, 24 May 1949.

ALPHA OMEGA—University of Georgia, Athens, Georgia, 17 May 1951.

BETA ALPHA—Pennsylvania State Univ., State College, Pennsylvania, 26 May 1955.

BETA BETA—Florida State University, Tallahassee, Florida, 18 February 1956.

BETA GAMMA—Long Island University Brooklyn N. Y., 27 April 1957.

BETA DELTA—University of Virginia Charlottsville, Virginia, 22 March 1958.

THE GOLDEN SYMBOL of Friendship

On campus and off, your pin has a powerful new appeal. It is the golden symbol of friendship, fashioned of gleaming karat gold and often set with precious jewels.

Proclaim your pride of membership by wearing your pin.

THE BALFOUR BLUE BOOK
The famous catalog of gifts and personal accessories—shown in color—sent free on request

Official Jeweler
to
Phi Sigma Society

L. G. Balfour Company
ATTLEBORO, MASSACHUSETTS

In Canada
L. G. Balfour Co. Ltd.
Montreal—Toronto

JEWELRY'S FINEST CRAFTSMEN